REMARKS

This Amendment is a duplicate of an Amendment filed herein on December 31, 2003 and is filed solely at the request of the Examiner who informed Applicant's undersigned representative that portions of the originally filed Amendment were not legible. Therefore, there should be no fee required for filing this Resubmission of Amendment.

Entry of this Amendment is proper since it narrows the issues on appeal and does not require further search by the Examiner.

Claims 15-27 and 56-75 are all the claims presently pending in the application. Claims 15, 20-21, 26-27 and 74-75 have been amended to more clearly define the claimed invention.

It is noted that the claim amendments herein are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims, or for any statutory requirements of patentability.

Further, it is noted that, notwithstanding any claim amendments made herein, Applicant's intent is to encompass equivalents of all claim elements, even if amended herein or later during prosecution.

Claims 15-16, 19-20, 27, 56, 60, 62, 65, 67 and 75 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Guenzer (U.S. Patent No. 5,478,653). Claims 15, 60, 65 and 74 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Wilk et al. (U.S. Patent No. 6,248,621). Claims 17-18 and 57 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Guenzer in view of Setsune et al. (U.S. Patent No. 4,980,339). Claims 68 and 70 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Guenzer in view of Yano et al. (U.S. Patent No. 6,096,434). Claims 71 and 73 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Guenzer in view of Ami et al. (U.S. Patent No. 6,610,548). Claims 21-22, 25-26, 61, 66 and 63-64 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Guenzer in view of Reisman et al. (U.S. Patent No. 4,891,329). Claim 69 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Guenzer in view of Reisman et al. and further in view of Yano.

These rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

Applicant's invention, as disclosed and claimed (e.g., see independent claim 15), is directed to a semiconductor structure which includes a substrate, a crystalline oxide layer including single-crystal oxide formed over the substrate, and an epitaxial silicon layer formed on the crystalline oxide layer.

In another aspect (e.g., as defined in claim 21), a semiconductor structure includes a substrate, a crystalline oxide layer including single-crystal oxide formed over the substrate, and an epitaxial germanium layer formed on the crystalline oxide layer.

In a third aspect (e.g., as defined in claim 27), a semiconductor structure includes a crystalline oxide surface including a single-crystal oxide surface, and an amorphous layer of at least one of silicon, germanium, gallium arsenide, aluminum arsenide, indium phosphide, aluminum antimonide, indium arsenide, gallium phosphide and mixed alloys thereof, deposited on the crystalline oxide surface by evaporation or chemical vapor deposition.

Conventional semiconductor structures include layers (e.g., epitaxial silicon layers) formed on oxide layers which are not single-crystal oxide. Such structures, therefore, do not form a structure in which the layers are lattice-matched, substantially defect-free and uniform (Application at page 3, lines 14-24).

The claimed invention, on the other hand, includes a layer (e.g., epitaxial silicon, epitaxial germanium, or an amorphous layer) formed on a crystalline oxide layer which includes single-crystal oxide (Application at page 8, line 2-page 9, line 16). This allows the claimed invention to form a structure in which the layers are lattice-matched, substantially defect-free and uniform (Application at page 9, lines 9-16).

II. THE 35 USC 112, FIRST PARAGRAPH REJECTION

The Examiner alleges that claims 74-75 are not enabled by the specification. Applicant note, however, that these claims have been amended to address the Examiner's concerns.

Specifically, claim 74 (and similarly claim 75) has been amended to recite "*wherein said crystalline oxide layer is perfectly lattice-matched to silicon*", which is clearly described in the present Application at page 8, lines 21-24.

Therefore, the Examiner is respectfully requested to withdraw this rejection.

III. THE PRIOR ART REFERENCES

A. The Guenzer Reference

The Examiner alleges that Guenzer teaches the invention of claims 15-16, 19-20, 27, 56, 60, 62, 65, 67 and 75. Applicant submits, however, that there are elements of the claimed invention that are not taught or suggested by Guenzer.

Guenzer discloses a bismuth titanate (BTO) layer allegedly used as a template layer for growth of crystallographically-oriented silicon. Specifically, Guenzer discloses an underlying layer of BTO which is polycrystalline (Guenzer at col. 1, lines 50-57).

However, Guenzer does not teach or suggest "*a crystalline oxide layer comprising single-crystal oxide formed over said substrate*", as recited in claim 15 and similarly recited in claims 21 and 27.

As noted above, unlike conventional semiconductor structures which do not include layers (e.g., epitaxial silicon layers) formed on oxide layers which are single-crystal oxide. The claimed invention includes a layer, such as epitaxial silicon, epitaxial germanium, or an amorphous layer, formed on a crystalline oxide layer which includes single-crystal oxide (Application at page 8, line 2-page 9, line 16). This allows the claimed invention to form a structure in which the layers are lattice-matched, substantially defect-free and uniform (Application at page 9, lines 9-16).

Clearly, these novel features are not taught or suggested by Guenzer. Indeed, the Examiner expressly concedes that this is not taught or suggested by Guenzer at page 7, lines 3-5 of the Office Action.

Therefore, Applicant respectfully submits that Guenzer does not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to

withdraw this rejection.

B. The Wilk et al. Reference

The Examiner alleges that Wilk teaches the invention of claims 15, 60, 65 and 74. Applicant submits, however, that there are elements of the claimed invention that are not taught or suggested by Wilk.

Wilk discloses a crystalline silicon layer formed on a perovskite barrier layer (Wilk at Abstract).

However, Wilk, like Guenzer, does not teach or suggest "*a crystalline oxide layer comprising single-crystal oxide formed over said substrate*", as recited in claim 15 and similarly recited in claims 21 and 27.

As noted above, unlike conventional semiconductor structures, the claimed invention includes a layer, such as epitaxial silicon, epitaxial germanium, or an amorphous layer, formed on a crystalline oxide layer which includes single-crystal oxide (Application at page 8, line 2-page 9, line 16). This allows the claimed invention to form a structure in which the layers are lattice-matched, substantially defect-free and uniform (Application at page 9, lines 9-16).

Clearly, these novel features are not taught or suggested by Wilk. Indeed, nowhere does the Examiner even allege that this feature is taught or suggested by Wilk.

In fact, the Examiner attempts to equate the barium strontium oxide layer 3 and the calcium strontium titinate layer 5 in Wilk with the crystalline oxide layer of the claimed invention. However, the Examiner is clearly incorrect.

Specifically, the layers 3, 5 in Wilk do not include a single crystal oxide and therefore, cannot be equated with the crystalline oxide layer of the claimed invention. In fact, Wilk merely describes these layers having a perovskite crystalline structure, but nowhere does Wilk teach or suggest that these layers include a single-crystal oxide (Wilk at col. 3, lines 39-57).

In addition, in complete and fundamental contrast, the oxide material of the claimed invention (e.g., as defined by new dependent claims 71-73) may be very different from a perovskite oxide, and may crystallize with the bixbyite structure. Such a difference is important

since the calcium-containing titanates of Wilk are much more reactive and have poor electrical properties. The claimed invention may include an inventive oxide material which is quite different.

Another key difference is that, in contrast to the recitations of new dependent claims 74-75, Wilk's crystalline oxide cannot be perfectly lattice-matched to silicon. That is, Applicant points out Wilk's usage of the phrase "substantially matched" (e.g., see Col. 4, lines 18-20).

Therefore, Applicant respectfully submits that Wilk does not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

C. The Setsune Reference

The Examiner alleges that Guenzer would have been combined with Setsune to form the claimed invention of claims 17-18 and 57. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Setsune discloses a superconductor structure which includes a coating layer formed by mixing either Ba, Sr, Ca, Be, Mg or ZrO_2 with a rare earth element (Setsune at col. 1, lines 39-57).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems and solutions.

Specifically, Guenzer is directed to a bismuth titanate (BTO) layer allegedly used as a template layer for growth of crystallographically-oriented silicon, whereas Setsune is directed to a superconductor structure . Therefore, these references are completely unrelated, and no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. In fact, contrary to the Examiner's allegations, neither of these references teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

However, neither Setsune, nor Guenzer, nor any combination thereof, teaches or suggests "*a crystalline oxide layer comprising single-crystal oxide formed over said substrate*", as recited in claim 15 and similarly recited in claims 21 and 27.

As noted above, unlike conventional semiconductor structures, the claimed invention includes a layer, such as epitaxial silicon, epitaxial germanium, or an amorphous layer, formed on a crystalline oxide layer which includes single-crystal oxide (Application at page 8, line 2-page 9, line 16). This allows the claimed invention to form a structure in which the layers are lattice-matched, substantially defect-free and uniform (Application at page 9, lines 9-16).

Clearly, these novel features are not taught or suggested by Setsune. Indeed, nowhere does the Examiner even allege that this feature is taught or suggested by Setsune.

Specifically, Setsune may teach a coating layer (e.g., for a superconductor structure) which includes a rare earth element (Setsune at col. 1, lines 52-57). However, nowhere does Setsune teach or suggest that this layer may include single-crystal oxide. Indeed, such a structure would likely have little benefit to the superconductor structure of Setsune. In short, Setsune is completely unrelated to the claimed invention. Clearly, Setsune does not make up for the deficiencies of Guenzer.

Applicant notes that mixed oxides with the perovskite structure do not render obvious a ternary rare earth oxide whose lattice constant can be made to match silicon. Additionally, a key feature of the claimed invention (as defined by new dependent claims 74-75) is to provide a material whose lattice constant matches Si. There is absolutely no recognition of this by either Guenzer or Setsune. Thus, in view of the foregoing, claims 17-18 and 57 are patentable over the teachings of Guenzer in view of Setsune et al.

Therefore, Applicant respectfully submits that these references would not have been

combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

D. The Yano Reference

The Examiner alleges that Guenzer would have been combined with Yano to form the claimed invention of claims 68 and 70. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Yano discloses a conductive oxide thin film formed on a substrate having a silicon (100) face at its surface. Specifically, Yano teaches that the conductive oxide thin film may be a zirconate with a rare earth component.

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems and solutions.

Specifically, Guenzer is directed to a bismuth titanate (BTO) layer allegedly used as a template layer for growth of crystallographically-oriented silicon, whereas Yano is directed to a film structure for forming conductive oxide thin films. Therefore, these references are completely unrelated, and no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. In fact, contrary to the Examiner's allegations, neither of these references teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

However, neither Yano, nor Guenzer, nor any combination thereof, teaches or suggests "*a crystalline oxide layer comprising single-crystal oxide formed over said substrate*", as recited in claim 15 and similarly recited in claims 21 and 27.

As noted above, unlike conventional semiconductor structures, the claimed invention includes a layer, such as epitaxial silicon, epitaxial germanium, or an amorphous layer, formed on a crystalline oxide layer which includes single-crystal oxide (Application at page 8, line 2-page 9, line 16). This allows the claimed invention to form a structure in which the layers are lattice-matched, substantially defect-free and uniform (Application at page 9, lines 9-16).

Clearly, these novel features are not taught or suggested by Yano. Indeed, the Examiner attempts to rely on Yano at col. 14, lines 24-30 and col. 15, lines 58-63 to support her allegations. However, these passages in Yano merely describe a zirconate with a rare earth component. This is basically what is known as rare earth stabilized zirconia. It is a different class of compound with a different crystal structure than the oxides that are contemplated by the claimed invention.

Indeed, the oxides in the claimed invention may include pure rare earths. That is, both components are rare earth compounds with valence 3 and their bonding to oxygen is different and their crystal includes a bixbyite crystalline structure. On the other hand, Zr is not a rare earth and since it is the majority component, it dictates the crystal structure and the bonding of the comound that Yano describes.

More specifically, in col. 15, lines 34-45, Yano teaches that the mixed rare earth oxide crystallizes with a cubic phase. The cubic phase is one of the 7 broad crystal classes. However, within that there are several different crystal structures. Zirconia with rare earths in them (like Yano) have a fluorite structure, which is one of the cubic crystal classes.

The oxides contemplated by the claimed invention (e.g., which are all rare earths), include the bixbyite structure, which is another of the cubic crystal classes. This has different symmetry and different crystallography than the rare earth zirconias (fluorite structure).

Another difference is in the valence and chemical composition. The structure of the claimed invention has the formula: $(A_xB_{1-x})_2O_3$, so that for every two metal atoms there are 3 oxygen atoms. In the zirconias, on the other hand, the formula is (also according to Yano, col 15 line 53) $Zr_{1-x}R_xO_{2-d}$, where for every metal atom there are only two oxygen atoms. The valence mismatch is further taken up by a fraction of oxygen vacancies given by the number d. This is chemically, valence and bonding wise, a completely different compound than the claimed

invention.

Thus, while both of these materials may indeed be cubic, the cubic class is a very broad class (most common materials are all cubic), and if one considers the crystal structure and valence/bonding issues, these are very different compounds. As an example, diamond and iron both are cubic, but they have different structures within the cubic categorization.

The Examiner also alleges that Yano teaches a method of forming a lattice matched structure with a mixed rare earth cubic oxide on silicon. This oxide may be epitaxial, but Applicant would point out to the Examiner that Yano does not teach that it is single crystal. A film may be epitaxial but it may not necessarily be single crystal but have textured epitaxial grains. In fact, it is not possible to grow Zr containing rare earth oxides (like Yano) that are epitaxial and single crystal. This is a very important distinction between Yano and the claimed invention.

Thus, Yano does not teach the growth of a single crystal epitaxial structures that is lattice matched. Instead, Yano only talks about an epitaxial lattice matched structures. This is an important difference. In addition, the crystal structures of Yano's compounds are different from the claimed invention (this is why Yano does not grow single crystal).

In summary, Yano does not teach forming a mixed rare earth oxide on silicon. Instead, he teaches about growing a zirconate with small rare earth content on silicon (col. 15, lines 15-20 of Yano, col. 15 lines 58-63, col. 16, lines 45-55). This is an entirely different compound than a mixed rare earth oxide. The zirconium oxide is the majority component and the rare earth is preferably much less (<5 %, Yano col. 16, lines 45-55). Yano deals entirely with zirconates, which are an completely different class of compounds with a different crystal structure than rare earth oxides.

In addition, Yano may touch briefly upon growing a rare earth oxide, but he only teaches growing it on ZrO_2, and not Si (col.17, lines 8-12). Further, Yano nowhere teaches or suggests epitaxially growing a silicon/oxide/silicon structure. Instead, Yano teaches only growing BaTiO3/zirconate/Si structures (col. 15, lines 15-20).

Therefore, Applicant respectfully submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every

element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

E. The Ami Reference

The Examiner alleges that Guenzer would have been combined with Ami to form the claimed invention of claims 71 and 73. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Ami discloses method of forming a ferroelectric non-volatile memory (Ami at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems and solutions.

Specifically, Guenzer is directed to a bismuth titanate (BTO) layer allegedly used as a template layer for growth of crystallographically-oriented silicon, whereas Ami is merely directed to a method of forming a ferroelectric non-volatile memory. Therefore, these references are completely unrelated, and no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. In fact, contrary to the Examiner's allegations, neither of these references teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

However, neither Ami, nor Guenzer, nor any combination thereof, teaches or suggests "*a crystalline oxide layer comprising single-crystal oxide formed over said substrate*", as recited in claim 15 and similarly recited in claims 21 and 27.

As noted above, unlike conventional semiconductor structures, the claimed invention provides a structure in which the layers are lattice-matched, substantially defect-free and uniform (Application at page 9, lines 9-16).

Clearly, these novel features are not taught or suggested by Ami. Indeed, nowhere does the Examiner even allege that this feature is taught or suggested by Ami.

The Examiner attempts to rely on Ami as allegedly teaching an oxide layer having a bixbyite structure. Applicant notes that Ami may disclose an oxide including a rare earth element (e.g., Y_2O_3) which may have a bixbyite structure, nowhere does Ami teach or suggest that the layer includes single crystal oxide. Therefore, Ami does not make up for the deficiencies of Guenzer.

In addition, Applicant would point out that the oxide layer of Ami is completely unrelated to the claimed invention. Indeed, the layer is formed on silicon oxide (e.g., not a silicon subsrate). Moreover, nowhere does Ami teach or suggest a layer (e.g., silicon, germanium or an amorphous layer) formed on the oxide layer.

Therefore, Applicant respectfully submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

F. The Reisman Reference

The Examiner alleges that Guenzer would have been combined with Reisman to form the claimed invention of claims 21-22, 25-26, 61, 66 and 63-64, and that the Guenzer/Reisman combination would have been further combined with Yano to form the claimed invention of claim 69. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Reisman discloses a method of forming a nonsilicon on insulator structure by forming a thin heteroepitaxial layer of nonsilicon semiconductor on a substrate having a lattice structure which allegedly matches that of the heteroepitaxial layer (Reisman at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems and solutions.

Specifically, Guenzer is directed to a bismuth titanate (BTO) layer allegedly used as a template layer for growth of crystallographically-oriented silicon, whereas Reisman is merely directed to forming a nonsilicon on insulator structure. Further, Yano is directed to a film structure for forming conductive oxide thin films and is, therefore, completely unrelated to either Guenzer or Reisman. Therefore, these references are completely unrelated, and no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. In fact, contrary to the Examiner's allegations, neither of these references teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

However, neither Reisman, nor Guenzer, nor Yano, nor any combination thereof, teaches or suggests "*a crystalline oxide layer comprising single-crystal oxide formed over said substrate*", as recited in claim 15 and similarly recited in claims 21 and 27.

As noted above, unlike conventional semiconductor structures, the claimed invention provides a structure in which the layers are lattice-matched, substantially defect-free and uniform (Application at page 9, lines 9-16).

Clearly, these novel features are not taught or suggested by Reisman. Indeed, nowhere does the Examiner even allege that this feature is taught or suggested by Reisman.

The Examiner attempts to rely on Reisman as allegedly teaching a thin layer of epitaxial non-silicon semiconductor formed on a crystalline layer (Figure 1C). However, nowhere does Reisman teach or suggest that the crystalline layer includes single crystal oxide. Indeed, the only oxide layer disclosed by Reisman is a silicon oxide layer 30, which will always be amorphous and will never be crystalline. Therefore, Reisman clearly does not make up for the deficiencies of Guenzer, and Yano does not make up for the deficiencies of the Guenzer and Reisman combination.

Therefore, Applicant respectfully submits that these references would not have been

combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

IV. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 15-27 and 56-75, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Assignee's Deposit Account No. 50-0510.

Date: 2/17/04

Respectfully Submitted,

Phillip E. Miller, Esq.
Reg. No. 46,060

McGinn & Gibb, PLLC
8321 Old Courthouse Rd. Suite 200
Vienna, VA 22182-3817
(703) 761-4100
Customer No. 21254

CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that the foregoing Amendment was filed by facsimile with the United States Patent and Trademark Office, Examiner Theresa T. Doan, Group Art Unit # 2814 at fax number (703) 872-9306 this 17th day of February, 2004.

Phillip E. Miller
Reg. No. 46,060